SENSITIVITY ANALYSIS OF THE HUMAN RESEARCH PROGRAM's IMPACT 1.0 Model

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IMPACT Overview

- **Includes data for 120 medical conditions from IMPACT Medical Database (MD)**
- **Simulate medical event occurrences over large number of missions via Monte Carlo methodology using MEDPRAT**
- **For each medical condition:**

Results Robustness

- **Best practices with computer modeling includes establishing the robustness of the model**
- **Robustness is the determination of how thoroughly the sensitivities of the model results to the variables and parameters of the model are known**
- **Infers an understanding of the sensitivity of the real-world system to potential changes in the variables and parameters of the system**
  - Assuming the imitated system behaves like the real-world system
- **Understanding the relative importance of variables and parameters, along with the relative ability to affect those variables and parameters, improves decision making**

Paraphrased from 7009 A

First Method Sensitivity Analysis: PRCC

- **Saltelli: "Sensitivity Analysis is the study of how variation in the output of a model can be apportioned, qualitatively or quantitatively, to different sources of variation (input) and how the given model depends upon the information fed into it."**
- **Partial Rank Correlation Coefficient (PRCC) Analysis**
  - Looks at how variance in conditions is affecting the model
  - PRCC is a combination of incidence (primary) and the subsequent paths, whose impact of variance is not uniquely assessed.
  - **Non-Technical Example:** If you have a radio it shows you which knobs to turn to get you the most effect on the output
- ***KEEP IN MIND* the difference between an influential condition and a sensitive condition**
  - Many conditions contribute substantially to the mean output of the model
    - Low sensitivity may indicate a "DC-signal effect" over the range of model application and parameter variance
    - Example: EVA-Related Shoulder Injury and Sudden Cardiac Arrest

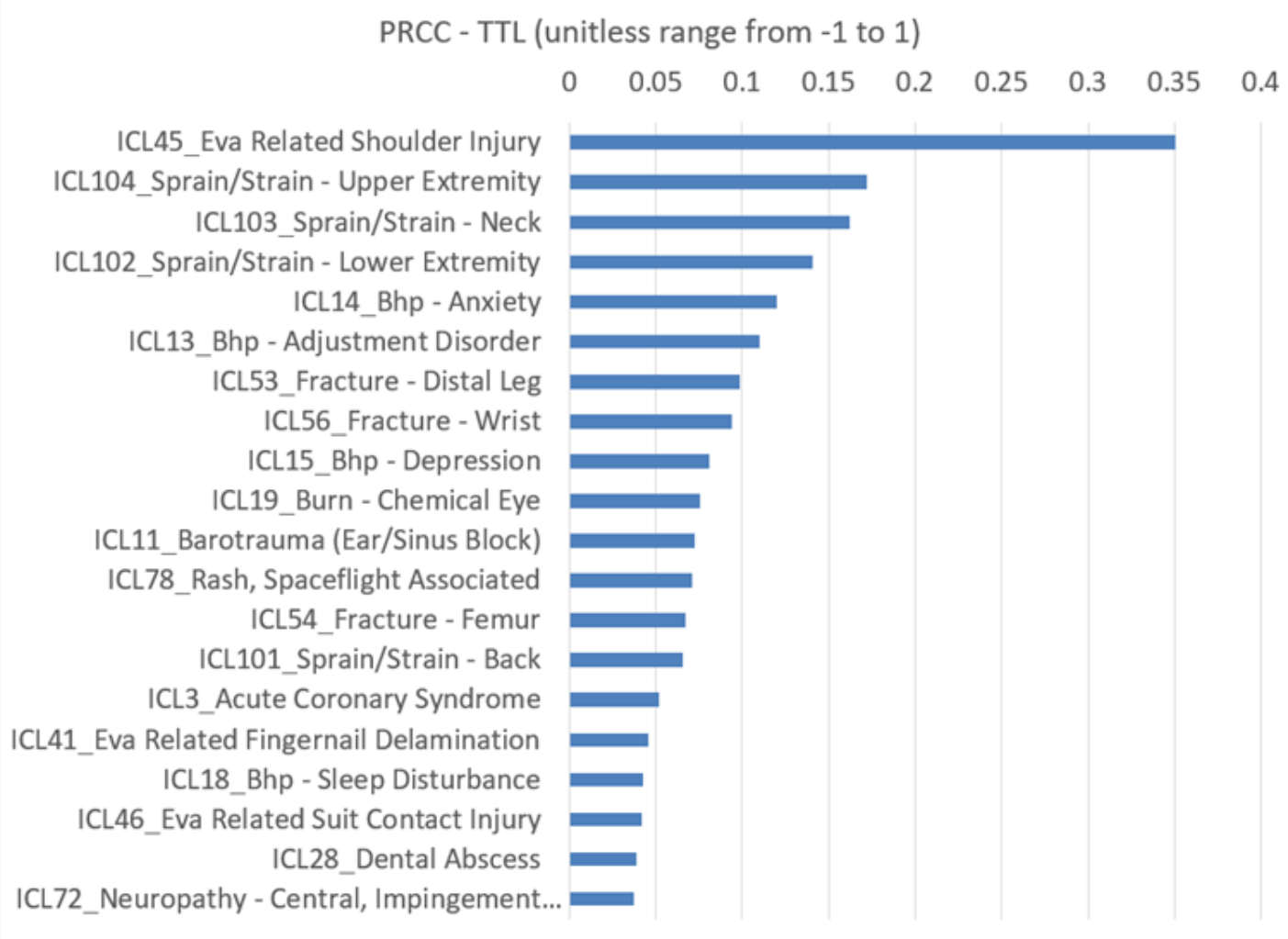
2nd Method Of Sensitivity Analysis: Leave One Out Analysis (LOO)

- **Leave One Out (LOO) Analysis**
  - Runs Baseline case with all 120 medical conditions
  - Removes a medical condition from the model and run the same mission with all remaining medical conditions
  - Compares the output of the model for both the baseline and condition removed cases
  - This examines the DC signal directly that PRCC does not
- **Looks at the magnitude of the change in the model**
  - Identifies influential conditions that are directly affecting the output
  - Overall effect of conditions
  - Useful for troubleshooting how conditions effects other conditions

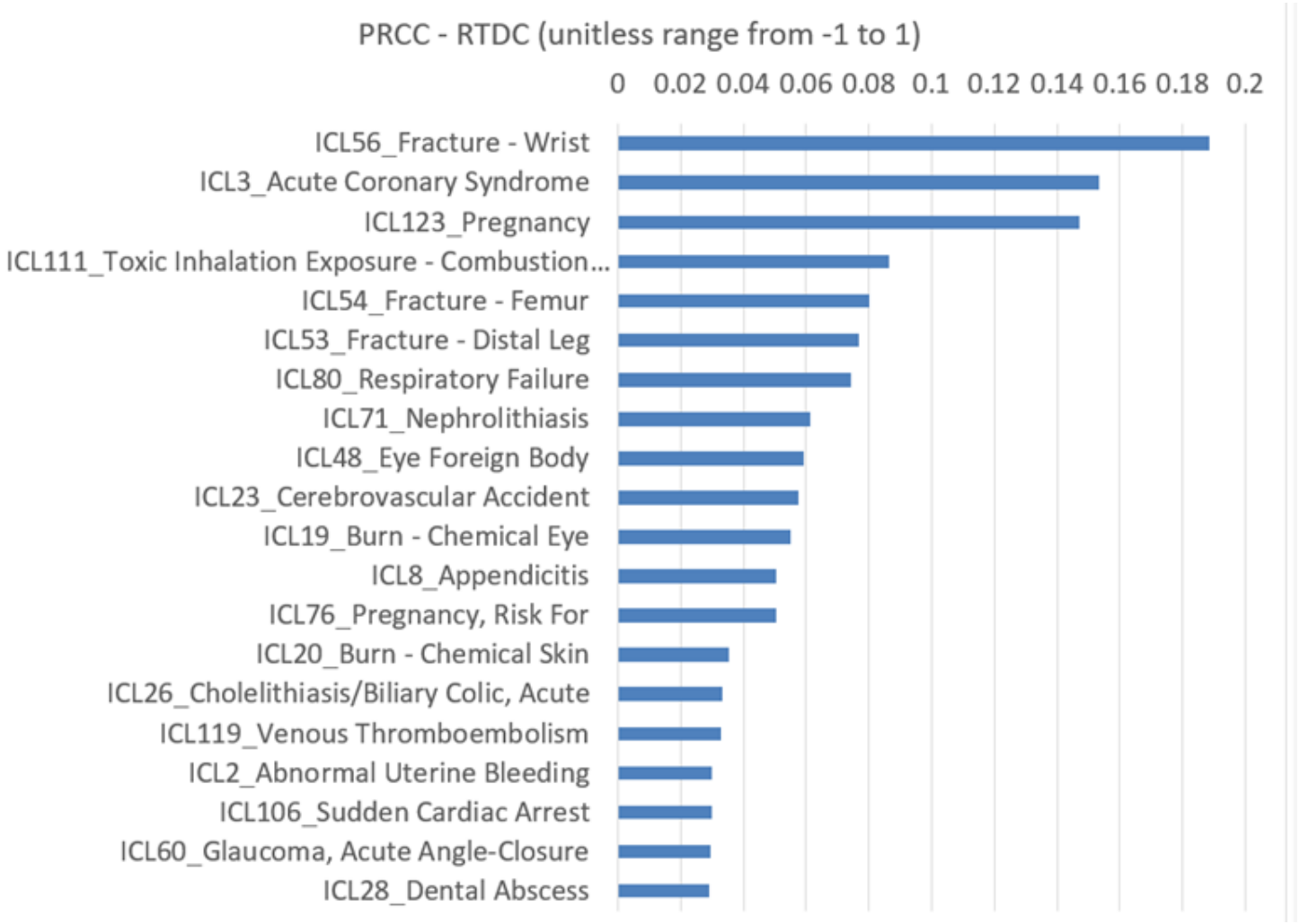
Using IMPACT for mission planning

- **IMPACT Provides probabilistic analysis of 120 medical condition occurrences and affects to mission outcomes**
- **Output: Using IMPACT Medical Database (MD) Lockdown 125**
  - Task Time Lost (TTL) – time lost due to medical events
  - Removal to Definitive Care (RTDC)
  - Loss Of Crew Life (LOCL)

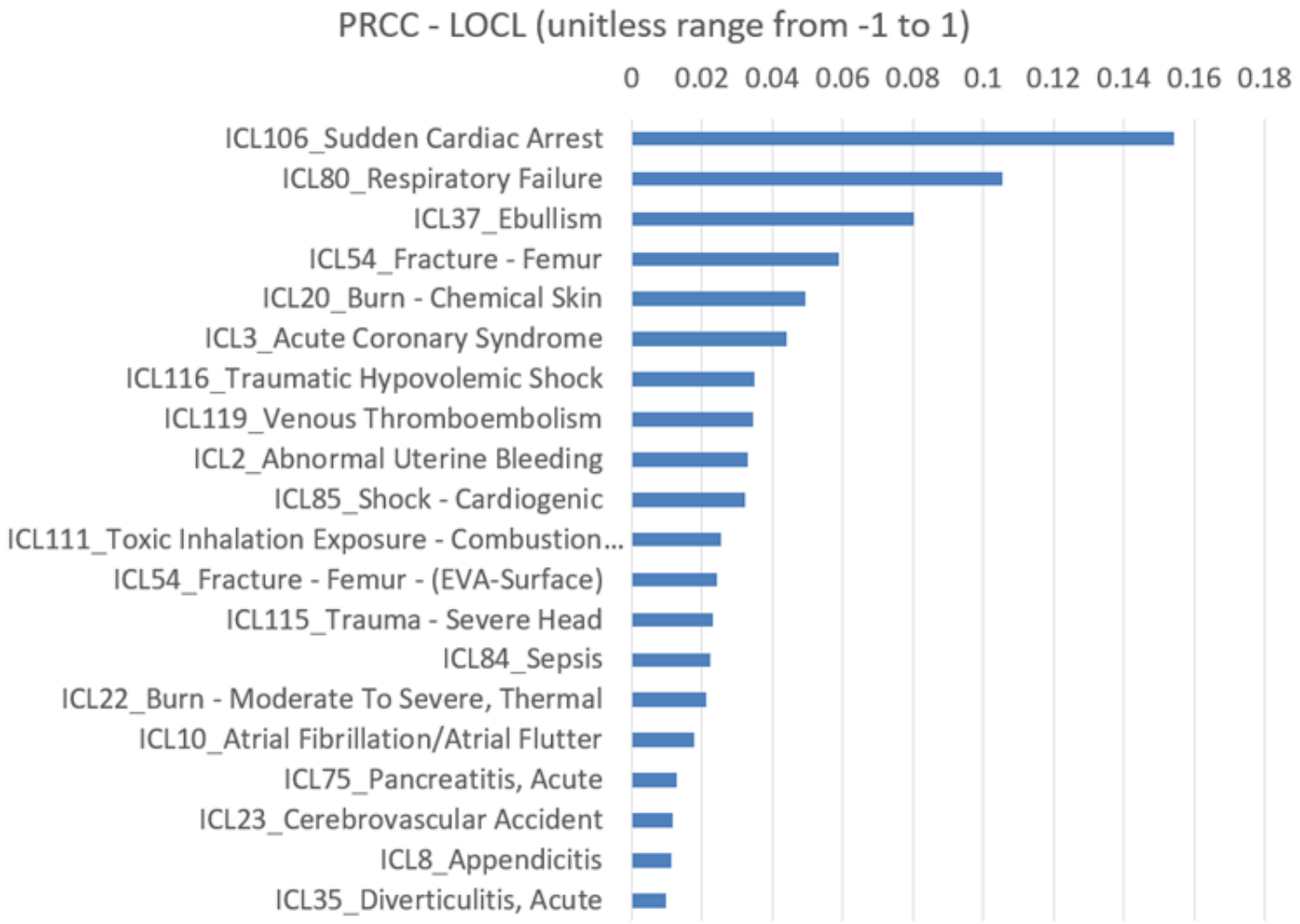
Task Time Lost - PRCC



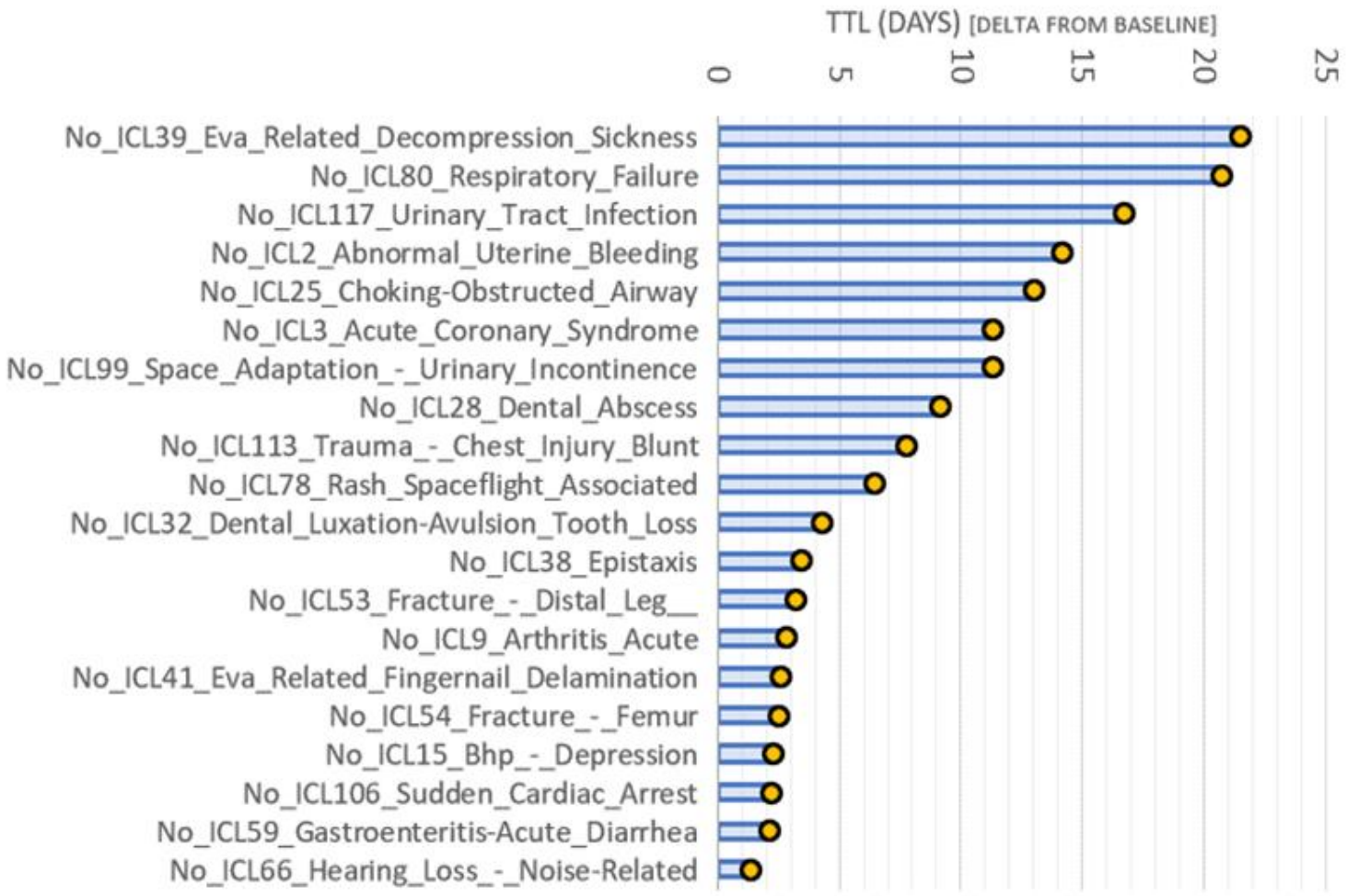
Removal To Definitive Care-PRCC



Loss Of Crew Life (LOCL)- PRCC



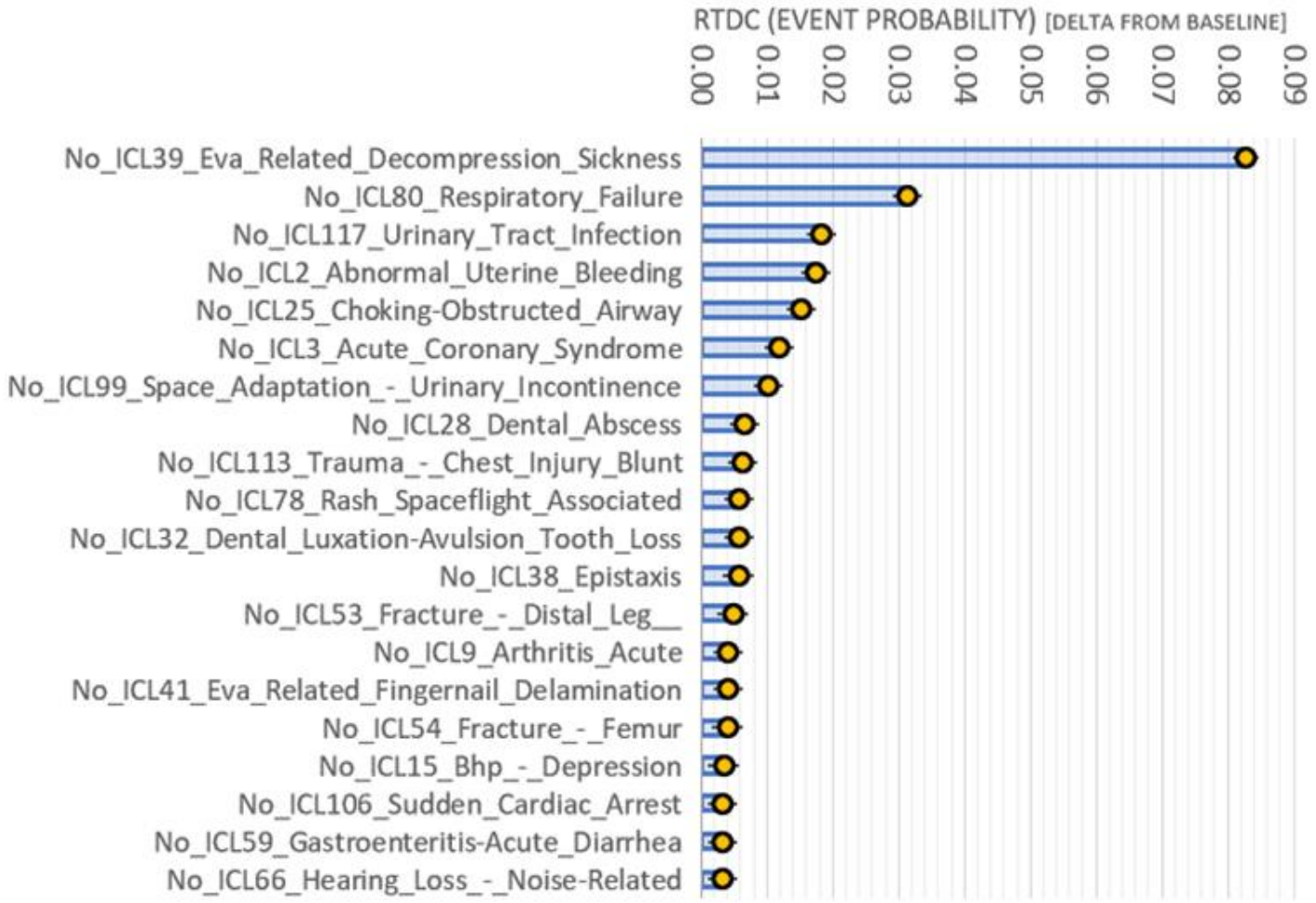
Task Time Lost (TTL)-Leave One Out



The TTL for a given design reference mission with the condition removed is subtracted from the baseline TTL including that condition

$$TTL_{Leave\ One\ Out} = TTL_{Baseline} - TTL_{with\ condition\ removed}$$

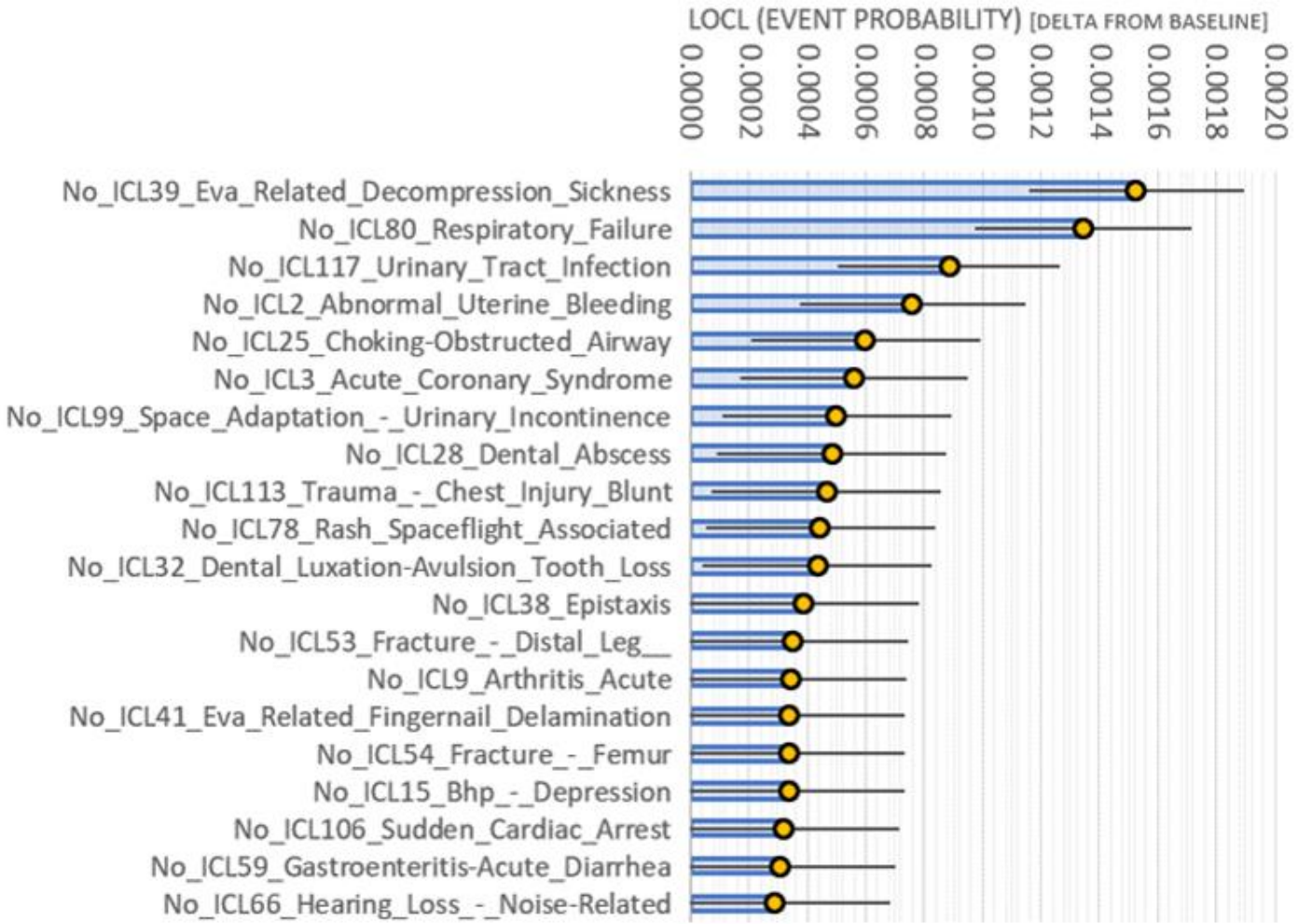
Removal To Definitive Care- Leave One Out



The RTDC for a given design reference mission with the condition removed is subtracted from the baseline RTDC including that condition

$$RTDC_{Leave\ One\ Out} = RTDC_{Baseline} - RTDC_{with\ condition\ removed}$$

Loss of Crew Life- Leave One Out



The LOCL for a given design reference mission with the condition removed is subtracted from the baseline LOCL including that condition

$$LOCL_{Leave\ One\ Out} = LOCL_{Baseline} - LOCL_{with\ condition\ removed}$$

Conclusions

- Successfully implemented a rigorous quantification of model sensitivity to parameter uncertainty per NASA 7009A
- By examining the sensitivity of conditions with a number of different methods this allows us to examine our assumptions of medical conditions more closely, and fine tune our medical sets for what is ultimately affecting our outcomes

Thank You

- **Any Questions?**